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this year; an individual member could then attend particular sessions, or all sessions, according as his interest and activities are specialized, or more general. A glance at this year's program shows the broad scope of the combined interests of the members of this association; and this scope is sure to become still broader as internal medicine grows and specialization in its various subdivisions increases. Thus, before long, the problems of "social medicine" are likely to engage us more than they do now. And I should like, in closing, to refer for a moment to this topic. Society at present tries, for its own welfare, to educate all citizens of the state. It may soon decide to try also to maintain the health and efficiency of all. Should society so resolve, a great extension of the municipal, state and federal medical services would become necessary to prevent disease; and the present method of treating patients at their homes would, in all probability, be largely replaced by hospital treatment. And if health should come to mean more than mere existence without outspoken physical disease—to include an abundant vitality, the capacity for joyous activity and for successful adaptation to the environment—then society, to maintain the health of its members, would have to see to it that the children born inherit bodies capable of normal responses to environmental stimuli, and further, that the various environmental stimuli to which individuals are exposed are beneficial to them and not too injurious. Such an ideal campaign for health seems at present a mere dream. But some dreams are prophetic forerunners of reality, and if we are to judge of the future by certain signs in the present, say by the institution of the *Krankenkasse* in Germany and by the movement toward a national medical service as advocated by Lloyd George in England, it may not be long before we shall, in this country, too, be taking some important steps forward in "social medicine." And when the time for this is at hand, we can be sure that this Association of American Physicians will be ready to throw its influence in the direction most helpful to society as a whole.

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THE MEANING OF GRADUATE STUDY[1]

It was a pleasure to me to accept the invitation tendered through your vice-president to appear before you to-night to speak on "The Meaning of Graduate Study." That it is important to every member of this club to have an adequate conception of this matter is obvious, and I shall not take time to emphasize this fact. I should like to say, however, by way of preliminary, that it is also vital to the university and to the state that both you and all the people of the state should be clear and accurate in your judgment as to the true nature and character of graduate work. On this depends, to a large extent, the success of the university and the measure of service which it may render to its constituency. I hope that the way in which your graduate study is thus vitally related to the university and to the community at large will appear with appropriate emphasis before I have done speaking.

We shall best avoid mutual misunderstanding if I state at the outset the answer which I have in mind to the question, "What is graduate study?"

In the first place it is not a further extension of undergraduate study. It is something different, not merely in degree, but rather in kind. The change from undergraduate to graduate work should be as marked as that from the high school to the university. On passing from the lower to the higher the student goes into a new atmosphere. He finds what is to him a novel attitude and point of

[1] Address to the Graduate Club of Indiana University, December 10, 1912.

view. He begins to look at science and the whole body of knowledge with anointed eyes, and presently the entire structure assumes a new aspect. The student is to be congratulated if this is accompanied by a revolution in his own mind, in his ways of thinking. If these vital inward changes do not take place there is usually little reason for his continuing in graduate work.

All graduate study which properly deserves the name involves research either directly or indirectly. It consists of three parts which are to be developed simultaneously, not successively: (1) One acquires the detailed and specific knowledge needed for research; (2) one develops the spirit of inquiry and consecration to the task of extending the bounds of knowledge—the spirit which characterizes the man of research; (3) one is inducted into the actual labor of discovery, and thus begins to experience what is perhaps the profoundest pleasure of which our nature is capable. Graduate study which lacks any one of these three elements is essentially deficient; it is not taken into account in our discussion below.

But what is research? What gives to it its central place of importance? What are the materials upon which it feeds? Let us first answer the last question.

The man of research should be free to choose his material wheresoever he will. A directing authority would ultimately be fatal to his vitality and destructive of all useful labor. But he must exercise an intelligent choice. Out of the myriads of facts in the universe selection must be made. Some are irrelevant; and these should be discarded. To determine the number of sprigs of grass on the campus or to count the lady-bugs on our planet is not research. These facts—though facts they are—have no permanent character; they do not lead anywhere.

True research consists of any one or more of three kinds of work of equal rank, as follows:

1. Ascertaining new facts of a permanent character or drawing attention to new relations among facts already known. This requires the power to direct attention to things which other people have overlooked, to separate them from the mass of facts in which they are imbedded and to study them first for their own sake and then in relation to other things. The man of research requires the power to see the mosquito on the monument and for the moment to forget the monument for the sake of the mosquito. It is so often the trivial thing which turns out to be important. It is of more concern to us to know the mosquito which holds the power of life and death than to contemplate the battle commemorated by the monument.

2. Deriving the consequences of facts already known. No fact is thoroughly understood until all its consequences are brought into review or the possibility of doing this has been clearly and definitely recognized. Indeed it is only when this has been done that we can be said to have ascertained that the thing is a fact.

3. Developing a body of theoretical doctrine, with or without reference to facts to be accounted for by it. Under this head come such matters as the Mendelian theory of inheritance, the electron theory, the mathematical theory of electricity, projective geometry.

Granting now this definition of research and its fundamental relation to graduate study as outlined above, the question arises as to when the student should begin the actual work of research. Should it be in the first year? Or, should one await a longer period of preparation in order to be better fitted for it? Probably no other subject requires as much preparation for research as mathematics, because in this the whole body of doctrine is closely connected and interdependent. Many extensive parts of it can be learned in essentially only one order. One may compare it to a tree. The trunk corresponds to the fundamental parts of the subject, the branches are the subdivisions, the remoter twigs are boundaries of present knowledge, and it is here that new truth is principally to be developed. Before one is ready for research he must ascend the trunk, so to speak, and climb out along some

vigorous branch to the twigs near its end. All this takes time. And yet, if my short experience is not misleading, this may be tentatively accomplished even in the first year of graduate study. To be sure, such early research is crude; it could hardly be otherwise. Probably one should seldom allow it to see the light of day, so far as publication is concerned. And yet to do such preliminary research is a matter of importance to the student. The power of independent thinking depends first of all on a certain natural aptitude, but it is capable of cultivation. The way to develop this power is to exercise it; and the sooner one begins the better. Too much acquisition and too little discovery undoubtedly benumb the faculty of initiative.

But how is one to get started on research with some promise of successful achievement? Is there a guide who can induct him infallibly into the inner secrets of the creative power? Fortunately or unfortunately, there is no flowered path leading through fields of research, in fact, there is no path at all; every one must blaze out his own trail.

Very few people have sufficient initiative to acquire this ability unaided, or even by the aid of books. The living instructor is usually essential. A certain body of traditional lore is passed on from generation to generation of thinkers and is never reduced to writing. One needs to draw from this source of inspiration. To acquire the power of research one needs to get close to some one who has it, to surprise him in the act of creative thinking and to learn his ways of working. No one is more pleased at this than the thinker himself, for he realizes how hard it is to transmit to others his acquisition, and yet he knows that this is the most important service which he can render. To transmit to others that elusive thing called point of view is at the same time the most important and the most difficult work of the instructor.

I have said that few individuals have sufficient initiative to acquire independently the power of research. On the other hand, I believe that there are many who may develop into successful workers if they come into intimate relations with a gifted instructor. The extraordinary success of students trained under such a man as Agassiz, for instance, is sufficient proof of this. He kindled a fire of enthusiasm which never burned out.

But why should one wish to acquire this power? The labor involved in its exercise is arduous. The material rewards are not great. The majority of one's contemporaries will not realize the importance of his work. In a little circle only, the inner circle of one's colleagues, will the labor be adequately appreciated. Therefore it is clear that whatever encouragement one has in undertaking such work must be of the higher sort, it must be ideal in its nature. To help you to see the true reasons for doing research is the principal purpose of this discourse.

First of all, what is the meaning of research to the individual who does it? What selfish end may he expect apart from the pleasure of service to his fellows? To do effective research is to know the spirit of mastery, the spirit of mastery where no one else suffers the pang of defeat. It is to develop the sense of superiority of mind over that which is not mind. It is consciously to obey the command to subdue the earth. It is to replenish it with a new creation. It is to make the universe a little fuller and richer by understanding it better.

But more than all this to the individual: he learns what it is to grow. Knowledge obtained otherwise is a sort of accumulation adhering to one outwardly; but when it is attained by independent research it is more like an integral part of one—not merely a possession, but an element of his very being. What I am saying will be made clearer by means of an illustration. A magnet attracts to itself iron filings and holds them indefinitely if they are not forcibly torn away; but however long they are kept in position, they do not become part of the magnet. The knowledge which is gotten by the usual means of acquisition is like these filings; it adheres to one externally. On the other hand, that which is discovered

through research is like the material which a plant takes up into itself in the process of growth; it becomes a part of one's essential being. Thus the work of research furnishes a means of self-development which is to be had in no other way. From this point of view to do such work will be a special privilege to one in proportion as he considers his individual development a matter of importance.

There is also a further advantage. When one has learned what it is to see a thing in the flood of light which research throws upon it, all knowledge begins to take a new appearance. The light of research reaches beyond the field in which it was kindled and illuminates the neighboring territory, and finally one's whole body of exact information. It puts one in a new world even while he is amid his old surroundings.

Let us next inquire, What is the meaning of research to the university? The way in which the reputation of the university, and consequently its power of service, depend on the character and amount of research done by its staff and graduate body is sufficiently objective to be in no danger of escaping your attention; and therefore I shall pass over this matter without further remark. But there is another thing more intimate, more subjective in its nature and more important in its influence, which, by its very closeness to your experience, may fail of appropriate recognition on your part. I refer to the atmosphere, in the academic community, which in large measure is created by your presence and work. This has a pervasive influence of a peculiar kind, and every environment which feels it is vitally affected by it. Every department of the institution is indebted to it for new tone and fresh vigor. A breath of life is infused into the undergraduate work and an inspiration otherwise unknown is felt. An institution in which pure research is regularly done has an atmosphere of its own which provides a training, even for the undergraduate who is not doing research, which can be secured in no other way. Through its students it contributes to the community at large a vital influence of far-reaching power.

It is obvious that a power of this kind may be utilized with different degrees of effectiveness. I believe that it often lies in part dormant, through the failure of graduate students to develop an appropriate *esprit de corps*. The great value to each individual of the spirit which pervades the undergraduate body is well known to all of you. A similar advantage may well accrue from the *esprit de corps* of an organized body of graduate students; and such a club as the present one is effective in contributing to this end. The wide divergence of interests in the various departments makes it harder to find common grounds of association than in the undergraduate work; but the advantages to be obtained are well worth an effort.

Again, let us ask, What is the meaning of research to the larger community of which the university forms a part? What immediate practical ends are attained? What more ideal and far-reaching results are accomplished?

It is one of the paradoxes of human progress that certain practical ends are best served by work which is laid out independently of practical considerations. It is only when one develops truth for the sake of truth itself that one takes sufficient time to forge all the links in the complete chain of theory. If the attainment of a practical end is the purpose in view minor matters which appear irrelevant will be entirely ignored, for the sake of economy of time. But if one is interested primarily in the development of science, no considerations, however unimportant they appear, are left out of account. One's esthetic sense can be properly gratified only by an all-comprehensive investigation of his subject. Consequently the man of research looks at his subject from all points of view and develops a complete theory simply for the sake of his delight in its beauty. When he has finished, it is often found that his discoveries are unexpectedly of great practical importance, sometimes directly and sometimes indirectly. Human progress owes a boundless debt to such agency.

Every science affords examples of the prac-

tical value of research to the community at large; but I shall not take time to enumerate any of these.

The chief value of science does not consist in the concrete advantages upon which we can readily lay our hands. All the beautiful results of an ideal nature which are accomplished for the individual researcher also accrue in a greater or less measure to the community at large. A new sense of mastery and adequate grasp of things pervades the general mind when the people realize that the thought of their generation is being developed in part by the men who go in and out before them. There is a feeling as of access to the inner circle of thought which is vivifying in its influence, when we know that those with whom we are associated are of the company of truth discoverers. There is a new tone to the community, and a fresh impetus to its study of the wider problems. Can any community remain the same when it receives a Newton, a Poincaré, a James, a vital man of research in any field?

This is a partial statement of the significance of research to the contemporary generation. But its influence reaches beyond the investigator's community or the political unit to which he belongs. It overflows into the whole world of thought, and thus contributes with great effectiveness to a modern movement which by many is believed to mark the beginning of a new era in human history. I refer to the widespread and universal feeling of brotherhood in man, a feeling of common sympathies and common interests which know no geographical or political or racial boundaries. The spirit of research, by its complete independence of everything which separates man from man, binds together elements of the most diverse origin into a common brotherhood in which all feel the same thrill of discovery, the same consecration to the task of extending knowledge, the same incentive to labor for human progress. It is the organizations of men of research which have the most effective international congresses; and the spirit which pervades these meetings is delightful. May we not see in this a forerunner of that day when all men will recognize the extent of their common interests, however diverse the outward forms of their life or their physical surroundings?

Whatever is of present advantage reaches out also to the future; and consequently everything which we have said so far may be applied in partial answer to the question, What is the meaning of research to the future of the human race? But such an answer is indeed partial; there are yet other essential things to add before it is made complete.

If we seek to look into the future we can succeed only by the light which is afforded by the past. Therefore let us examine briefly certain typical instances illustrating the way in which the research of one period has had its full fruition only in succeeding generations. You will pardon me if I draw these principally from the field with which I am best acquainted.

In the great days of ancient Greece her mathematicians were deeply interested in the study of the various curves which may be obtained as the intersections of a circular cone and a plane; and they developed many of the properties which belong to them, especially those of a metric nature. The incentive to this study was the esthetic delight in the body of doctrine itself; no important practical applications of their results were found—none was sought. For many generations this Greek theory of conic sections was transmitted without essential modification and without application to practical matters. Finally, through his acquaintance with this theory, Kepler was led to observe that planetary paths are a special kind of conic section; and his famous three laws of astronomy were discovered and made known. After a further lapse of time, Newton's meditations on Kepler's laws led to his formulation of the theory of gravitation, with the fundamental law of inverse squares as the basis. This in turn furnished the necessary foundation for celestial mechanics, and this magnificent structure was reared by several workers, notable among

them being Laplace. If we follow this chain further we shall find that celestial mechanics became the model for an exact science of any class of natural phenomena; and men sought to fashion the whole of mathematical physics after the same plan. It would be hard to overestimate the influence exerted in this way on modern science with all the practical consequences which it has introduced. It is fair to say that we are now reaping some of the practical benefits of the old Greek theory of conic sections, since this theory furnishes one of the essential tools by means of which our present body of science has actually been developed.

Let us take from Greek mathematics another example which illustrates the way in which the value of research is cumulative. Consider Euclid's geometry. It contains an ideal body of doctrine whose form is evidently determined by the author's delight in logical consistency and coherence. It is even yet a model according to which one fashions a careful logical exposition. As is well known, the ordered sequence of its propositions was the guide of the English philosopher Hobbes in constructing his body of philosophical doctrine.

A more recent and totally different kind of example of the value of research is afforded by Mendel's theory of inheritance. About fifty years ago Mendel was engaged in ascertaining the effect produced in various characters by crossing two varieties of peas; for the explanation of the facts which he gathered he offered a theory of inheritance which has since had a remarkable influence on biological thought. And now it appears as if results of profound importance to human progress will arise from the increased knowledge of heredity which Mendel's laws afford.

Examples of this kind might be multiplied indefinitely. The way in which practical consequences of great value have come unexpectedly from research in the past reminds us indeed that specific prediction is useless. When we notice the marvelous rapidity with which scientific facts are now gathered and compare this with the experience of the past, when we see the present magnificent consequences from the relatively meager material for work in the older time, we feel like asking, What is to be the future of research? To what grandeur will it attain? What blessing will it not bring to the human race? One does not dare to assign a limit to its possibility. How far short of the present marvels of science would have been the boldest predictions of the fathers of a hundred years ago!

A work which in the past has proved itself of so profound importance deserves adequate support in the present. Whence is such support to be derived? I wish to answer this question by saying that every unit in the world community should contribute to it. The state of Indiana should sustain her proper share of men of research, and for the further reasons which I am about to state.

That community in which research of the best quality and greatest amount is done will profit most by the total research of the world. Of course those communities which contribute nothing will in the end receive great benefit also. It will be later in coming to them and it will not manifest that vitality which characterizes it in more favored places; but it will come. A sense of fair play and a wish to profit to the fullest extent require, however, that each state shall properly support research in its own borders. Otherwise it becomes a sort of leech drawing its sustenance in part at the expense of the world at large. And no patriotic citizen can ever consent that his state shall be a pensioner on the bounty of others; it must do its part in the work of general progress.

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THE TENTH INTERNATIONAL GEOGRAPHICAL CONGRESS

UNDER the sunniest of Italian skies the tenth International Geographical Congress was convened on the morning of the twenty-seventh of March in the historic Aula of the palace of the Campidoglio in Rome. His Majesty,